Some Comments Regarding Performance Potential for a New Machine Gun and Ammunition Concepts

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General Outline

- **Summary**
- **Introduction**
- **Brief Technical Overview**
- **Ammunition**
  - **Emphasis on lightweight, high V_0, very low drag projectiles = high kinetic energy to deposit on target**
- **Brief Comparison of Trajectory Profiles**
  - **Proposed vs. current**

Conclusion

- **It is strongly recommended that the key technologies be brought together to result in a modern, high performance, effective machine gun system that is a superior weapon in the field.**

Summary

- **Conceiving, developing and fielding a weapon system is not an easy task.**
- **Perhaps that is why we shy away from replacing tried and tested systems that have been used for almost the past century.**
- **This brief presentation points out some of the advances in technology that can be applied to a new high performance machine gun system.**

Comments on .50 Cal Heavy Machine Gun

- **Technology from the end of WWI (1918).**
- **Cartridge volume is limited. No significant increase in performance.**
- **Saboted Light Anti-Material Penetrator (SLAP) performance limited.**
- **Overall gun-ammo system limited for performance upgrade.**

Aerodynamicist’s Golden Rule

“Assume Everything, But the Responsibility.”

Current and Proposed Heavy Machine Gun Systems

		Wt (lb)	V_0(ft/sec)
• US	12.7mm(.50cal)	0.1014	2,800
• US	15.24mm(.60cal)		
• US	16.51mm(.65cal)	0.0794	5,000
• Soviet	14.5mm(.57cal)	0.1391	3,511
• US	29mm M246	0.2267	3,380

Characteristics of Well Designed Tubular Projectiles

- **High muzzle velocity +Low drag shape =**

  High kinetic energy + short time of flight = relatively flat trajectory = high hit probability

  Performance bonus = high gyroscopic stability = anti-ricochet

Relatively New Technologies
(Since Browning .50 Cal was Accepted)

- **Aeroballistic**
- **Interior Ballistics**
- **Materials (high strength & light weight)**
- **Computer Aided Design**

Projectiles

- **Tubular w/ Incendiary**
  - **Pusher/obturator**
- **Multipurpose**
- **Consumable**
- **Conventional w/ HE Charge**
- **SLAP**

Interior Ballistics

- **Compacted propellant**
  - **(Proprietary designs and concepts)**
- **Ignition Techniques**
- **Lightweight projectile**
- **Mass (M) + High muzzle velocity (V) = High kinetic energy ($1/2MV^2$)**
- **Equates to: Shorter time of flight to a given distance + some aerodynamic lift combined with low-aerodynamic drag = a relatively flat trajectory**

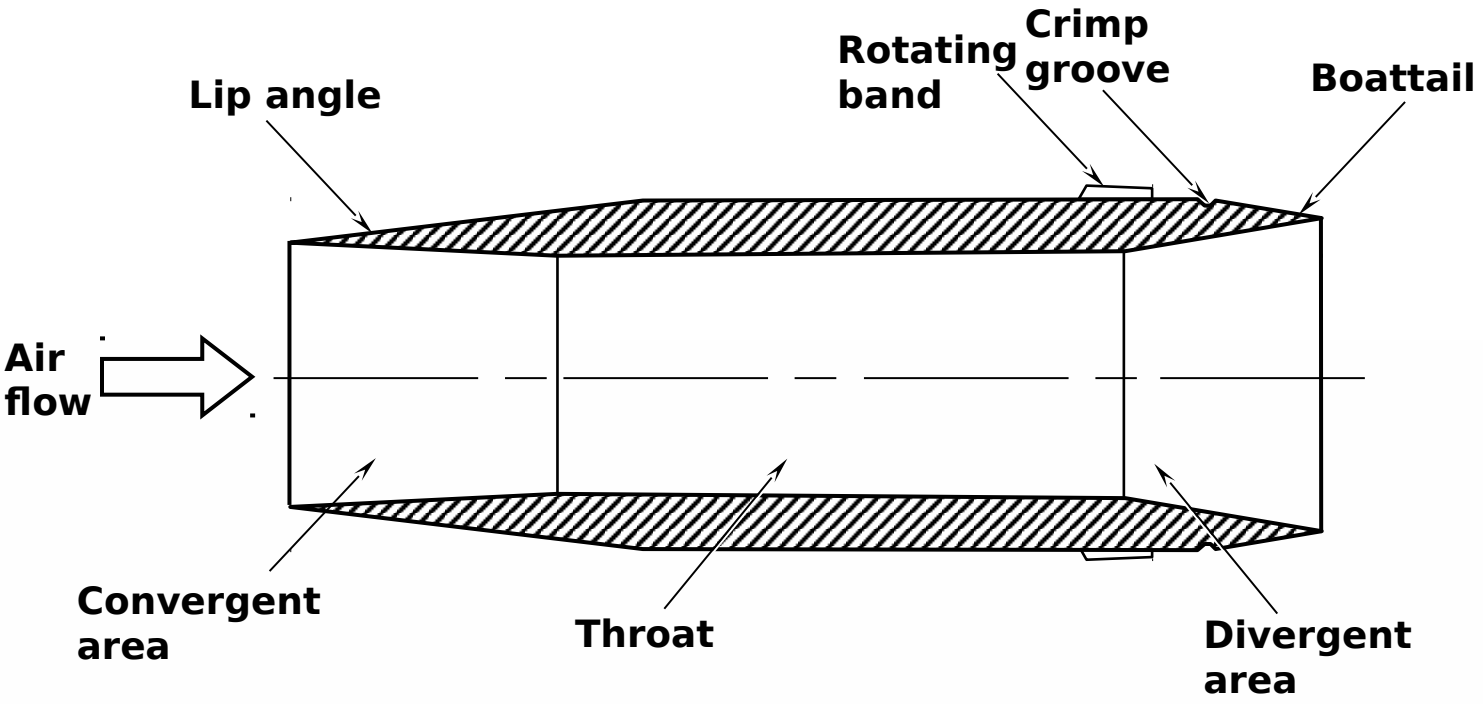
Packing Density

- **WWII Propeller Aircraft**
- **Jet Fighter**

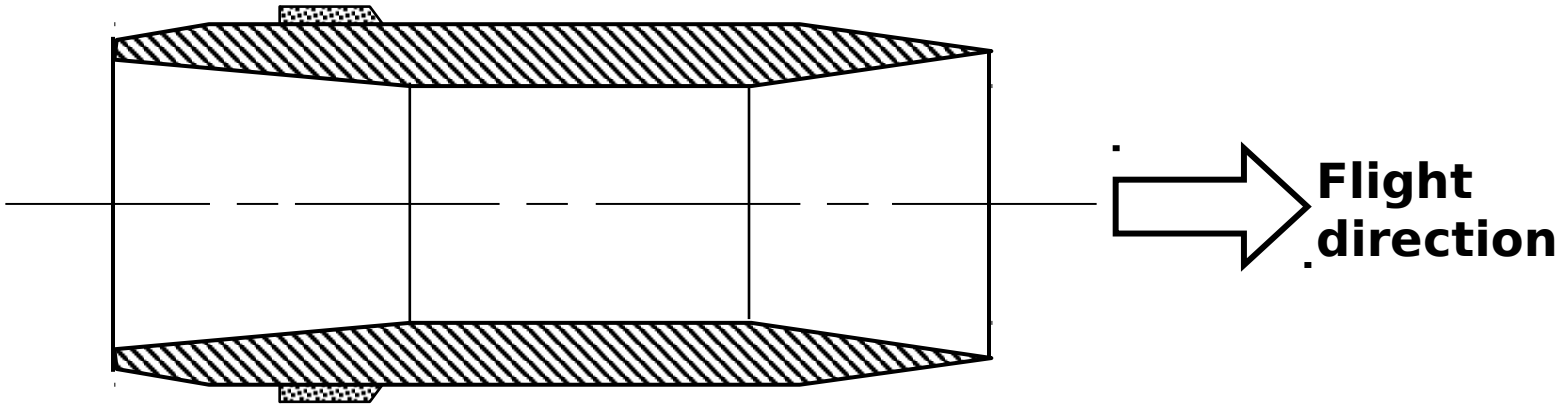
Conclusion

- **It is strongly recommended that the key technologies be brought together to result in a modern, high performance, effective machine gun and ammunition system that is superior to other gun-launched weapons in its general class.**

Full-bore Tubular Projectile Configuration



Basic Characteristics of Tubular Projectiles

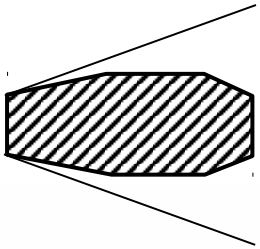


- Low supersonic drag
- Light weight allows increased muzzle velocity
- High gyroscope stability

External Flow Characteristics of Tubular Projectiles

High Mach Number

Direction of flight

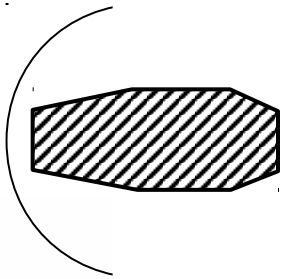


Swallowed flow

- No bow shock on or in front of nose
- Low drag

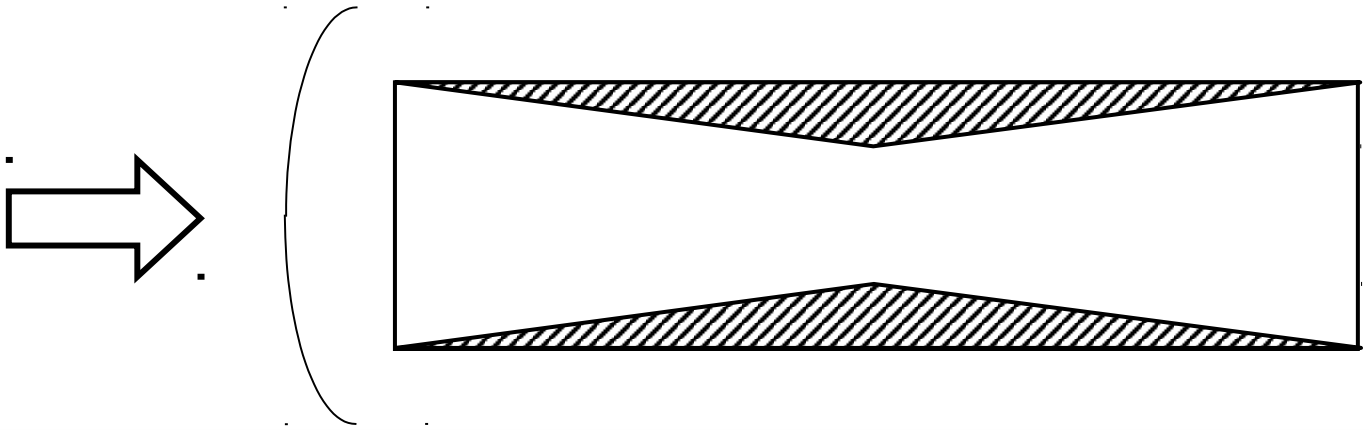
Low Mach Number

M ≅ 1.9



Choked flow

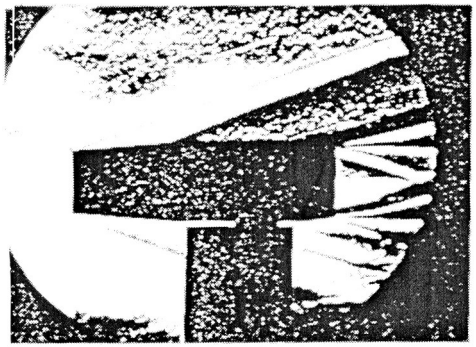
- Bow shock
- High drag



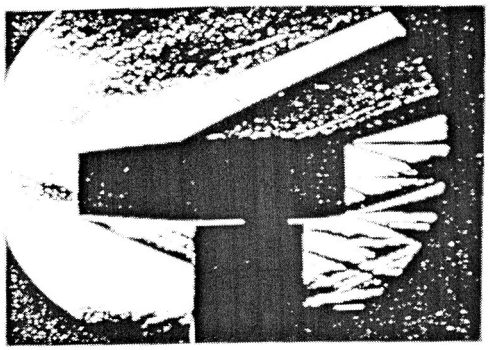
Bow shock associated with “choking” and high drag

Note: Above shape is known as a Busemann Biplane and also as an “internal” design

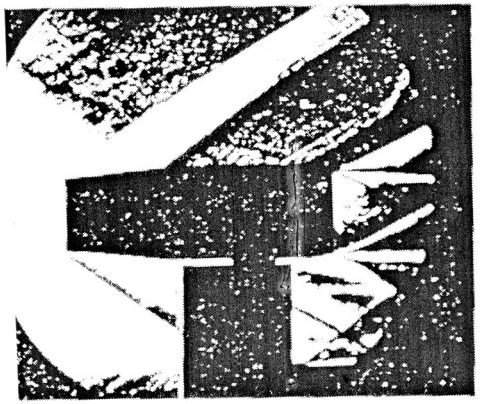
Schlieren Photographs of TCD-3 WSCO Supersonic Wind Tunnel Variable Mach Number Operation



M ≅ 3.0



M ≅ 2.5



M ≅ 2.0

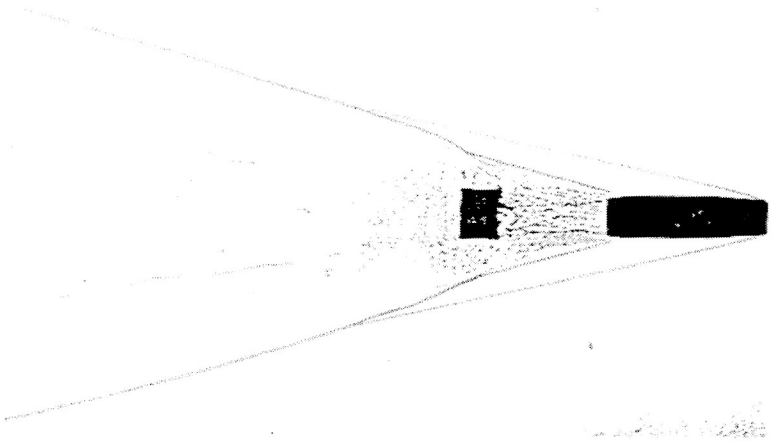
M ≅ 1.6

Before high drag condition

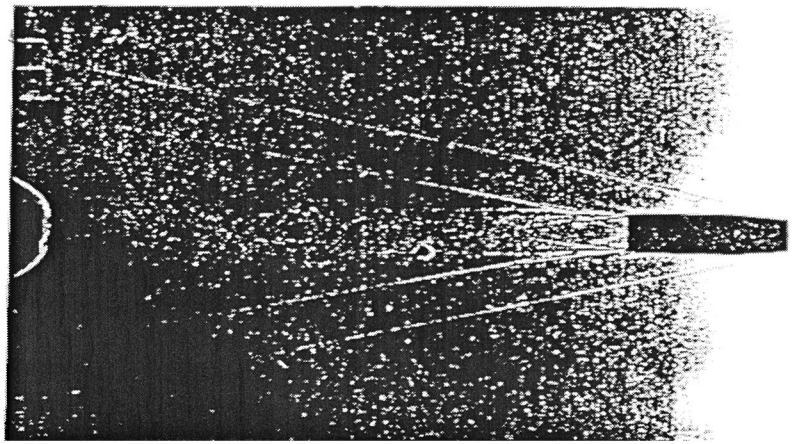
High drag condition

Aeroballistic Range Photographs/TCD-3

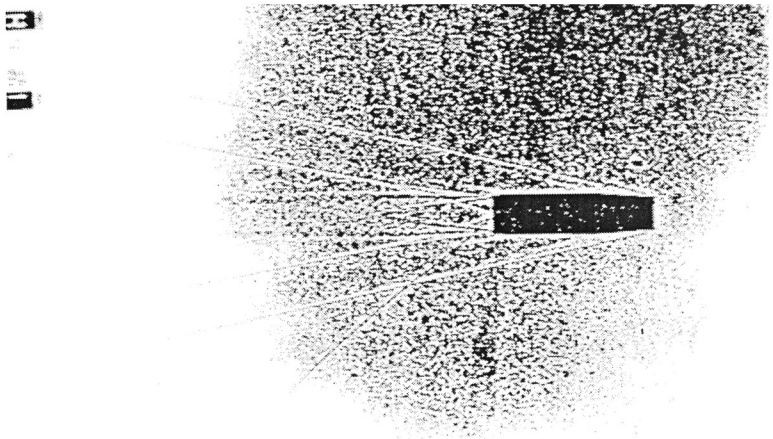
M ~ 40



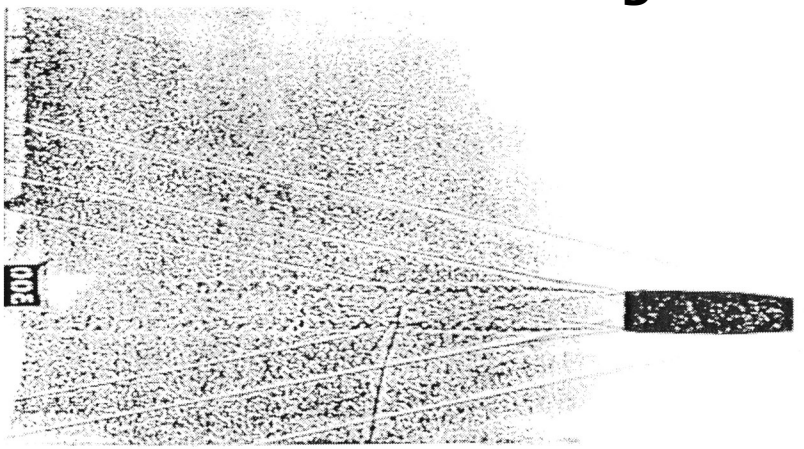
Near muzzle



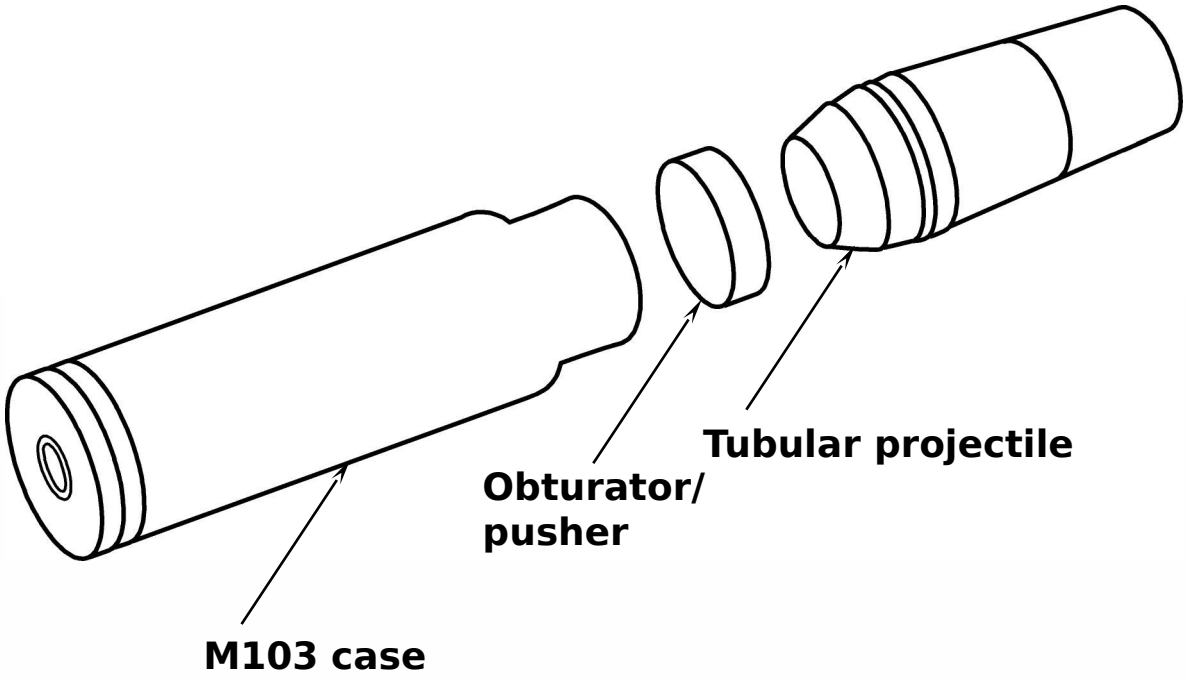
15 feet down range



20 feet down range



300 feet down range



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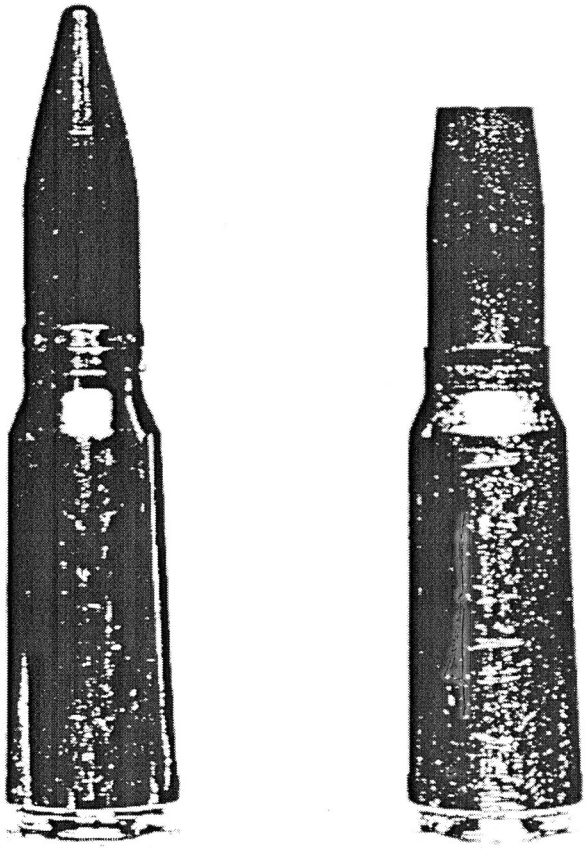
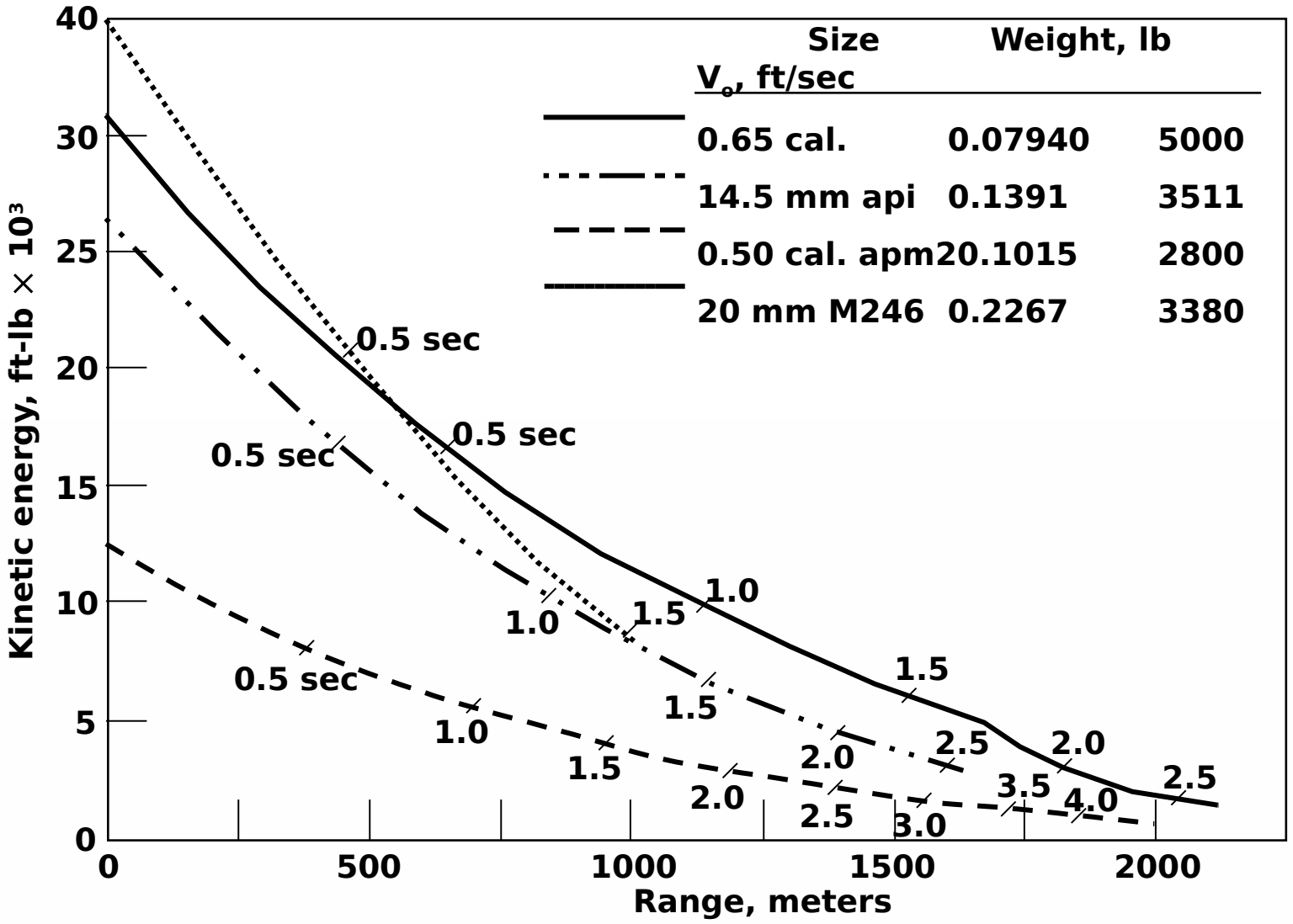


Potential Advantages of Tubular Projectiles

- Higher launch velocity (lighter weight)
- Shorter time of flight
- Near straight-line trajectory profile
- Simplified fire control

Kinetic Energy vs. Range



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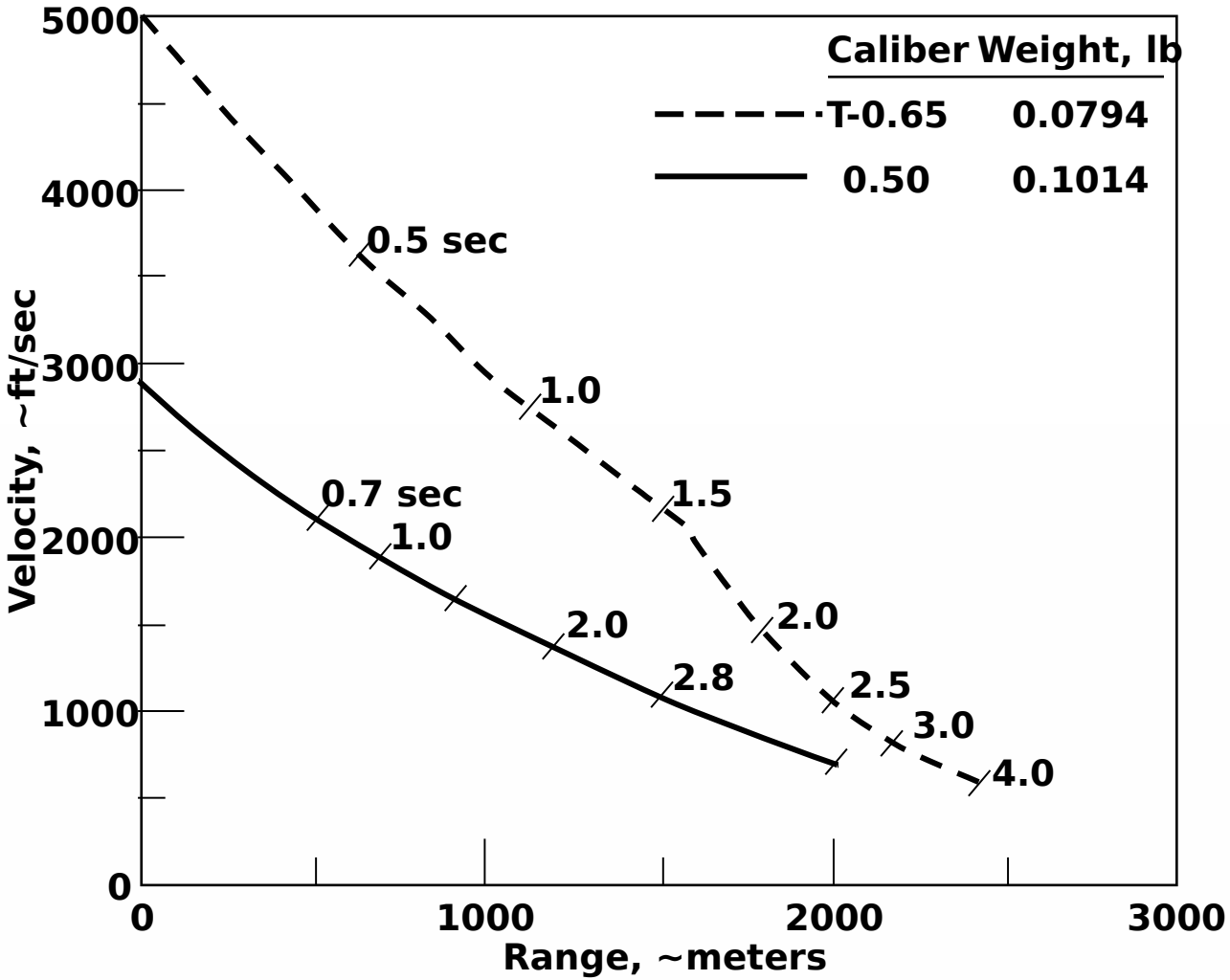
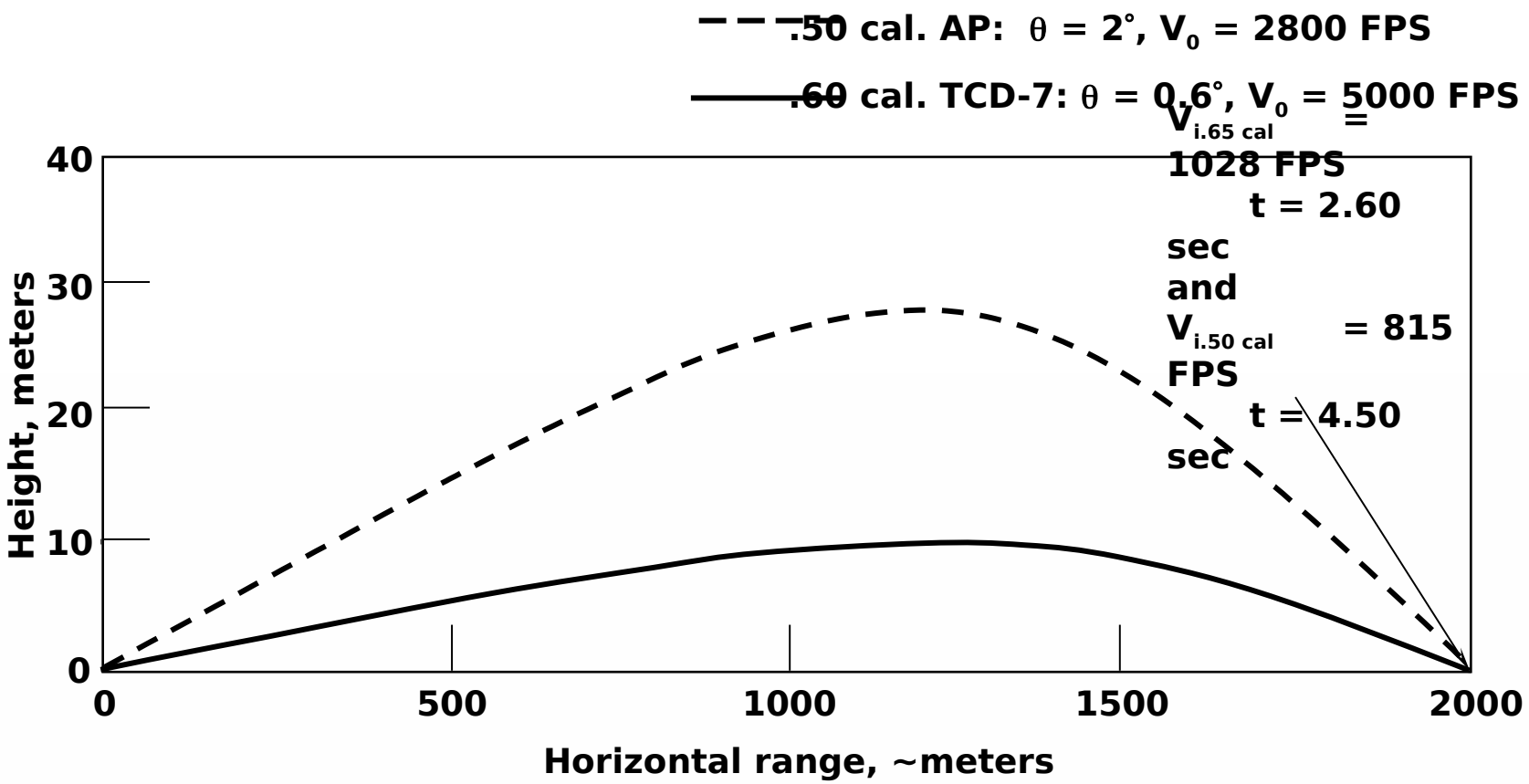
T-0.65 Caliber vs. 0.50 Caliber



Representative Trajectory Profiles



Summary of .65 Caliber Tubular Projectile Characteristics

- Significant increase in kinetic energy over .50 caliber
- Terminal ballistics far superior to .50 caliber AP
- Flatter trajectory than .50 caliber
- Shorter time of flight than .50 caliber
- Greater range than .50 caliber
- Low weight system/low cost ammunition

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“That’s how Research and Development put the pressure on. First they hustle you to promise them results. Then they hustle you some more to promise them results <u>in our lifetime!</u>”